

32. *Tachyris cardena*.

Pieris cardena, Hewitson, Exot. Butt. ii., *Pier.* pl. iii. figs. 17, 18 (1861).

Borneo, Sumatra, Malacca. 13 ♂, 1 ♀. B. M.

The examples from Malacca may have to be separated, the yellow on the under surface of the secondaries being replaced by a much more restricted abdominal patch of orange.

33. *Tachyris hagar*.

♂. *Pieris hagar*, Vollenhoven, Mon. Pier. p. 38, pl. iv. fig. 6 (1865).

Sumatra.

I think it quite likely that this is only a dry-season form of the preceding species.

34. *Tachyris Hombronii*.

Pieris Hombronii, Lucas, Rev. et Mag. de Zool. 1852, p. 325; ♀, Vollenhoven, Mon. Pier. p. 5, pl. ii. fig. 3 (1865).

Celebes. 3 ♂, 1 ♀. B. M.

This curious and handsome species leads pleasantly from the present group towards *Prioneris*, of which it has the general form and aspect, though without the serrated costa.

LVII. — *The Entomostraca of Lake Bassenthwaite*. By EDITH M. PRATT, B.Sc. *With an Introductory Note* by SYDNEY J. HICKSON, M.A., F.R.S., Beyer Professor of Zoology in the Owens College, Manchester.

Introduction.

THE splendid researches on the character of the fresh-water fauna which have of recent years been made by Zacharias at Plön, by Birge at Mendota, and by many others abroad, serve to remind us how ignorant we are of the fauna of our own English lakes.

Investigations of the inland waters of Scotland have been conducted for some years by Scott* ; but Beck's † paper is the only one that gives a systematic account of the Entomostraca of the English lakes.

As Beck's investigations were chiefly made in the autumn months it occurred to me that it might be of interest to inquire into the character of the fauna earlier in the year, with the

* Scott, T., Scottish Fishery Reports. Scient. Invest. 1890 onward. Invertebrate Fauna of Inland Waters of Scotland.

† Beck, C., J. R. Micr. Soc. (2) iii. p. 780

object of noting the principal differences that presented themselves in the early spring and in the autumn.

Accordingly in April 1897, when the weather was still very cold and blasts of icy wind blew down in gusts from the snow-capped Skiddaw, I took a few samples of the Plankton as a preliminary step to further investigations. The material I then obtained proved to be of considerable interest, containing among other things the interesting *Nauplius* larva of *Leptodora*.

In April of this year, the weather being decidedly warmer than in the corresponding time of 1897, I obtained the assistance of Mr. J. T. Wadsworth, and made with him a considerable number of gatherings in various parts of the Lake, so that it may be said that we obtained a fair sample of what the Plankton is at that time of year.

Again, in June, with the assistance of Mr. J. H. Ashworth, B.Sc., another long series of tow-nettings were taken which show the remarkable change that takes place in the character of the Plankton during the first two months of the summer.

I have to acknowledge here my thanks to Mr. Ashworth and Mr. Wadsworth for their skilled assistance in this investigation.

As my time was fully occupied during the summer months I entrusted the duty of identifying the species to my former pupil Miss Edith Pratt, B.Sc., of the Owens College; and the results of her investigations are recorded below.

It cannot be supposed that the list of Entomostraca which is now given as occurring in Lake Bassenthwaite is by any means complete. A complete list will be drawn up only when a series of gatherings are taken every month for two or three years; but it may be hoped that the publication of this paper will act as a stimulus for further investigation.

It is well known to fishermen that the lakes in Cumberland vary very considerably in their "trout" reputation. Bassenthwaite is not regarded as a very good lake for trout, but, on the other hand, it contains an abundance of perch and pike. It would be extremely interesting if in time a systematic study of the relations between the fish-fauna and the Entomostracan fauna could be undertaken. It would not be a very costly investigation, but it would require the whole time of a competent naturalist provided with a modest laboratory on the lake side for a period of two or three years. The results to be obtained might be of considerable value to the fishery.—S. J. H.

BASSENTHWAITE LAKE is particularly well suited for faunistic investigations, for while being one of the lowest of the English lakes, it has the largest drainage-area; it also receives the overflow from Derwentwater and Thirlmere; therefore in Bassenthwaite we should expect to find a typical lake-fauna, and, in addition, a concentration of the forms living within the drainage-area of the lake.

Bassenthwaite* is the same size as Derwentwater—a little over 2 square miles in area. It is 3·83 miles in length, its average breadth is ·054 mile or 950 yards. The widest part of the lake is exactly $\frac{3}{4}$ mile. The surface of the lake is 223·4 feet above the sea-level; the average depth is 18 feet; the greatest depth is 70 feet. Direct drainage-area 91½ square miles; total catchment-area 134 square miles.

The upper end of the lake is shallow, and depths over 25 feet are confined to a trough nearly 2 miles long in the middle of the lake. The section across the lake suggests a double-troughed depression separated by a broad central rise. Mill says:—"The steep slopes of the lake above and below water were always composed of smooth rounded stones, much smaller than the great blocks of Derwentwater; the stones were only observed to be covered with mud on the shallow flats at the north-west and southern ends, and except for some rushes and water-lilies in the south-eastern corner, there were remarkably few water-plants, and no signs of a peaty floor. Well out in the lake the sediment was always found to be soft mud." The soundings were taken on June 24th and 26th, 1893.

On 4th April, 1897, a few tow-nettings were roughly made in the lake, with the view of ascertaining the nature of the fauna. The following forms were taken:—COPEPODA: *Diatomus castor*, *Cyclops strenuus*, and *C. signatus* were fairly common; *Cyclops affinis* was rather rare. DAPHNIDÆ: *Bosmina longirostris* and the larvæ of *Leptodora hyalina* were fairly common.

On 21st and 22nd April, and 15th, 16th, and 17th June, 1898, the investigations were more thorough, and the middle and northern portions of the lake were carefully worked at.

In April ten tow-nettings were taken, six at the surface and four at a depth of from 5 to 6 feet. The preservatives used were (1) a solution of corrosive sublimate, and (2) a mixture of formol, spirit, and osmic acid; the latter obtained better results than the former.

On 21st and 22nd April, 1898, it was noticed that the

* For a complete description of Lake Bassenthwaite see 'Bathymetrical Survey of the English Lakes,' by H. R. Mill, D.Sc.

Copepods were most abundant some little distance below the surface, while the Daphnids were found in greatest numbers at the surface. The following forms were taken:—COPEPODA: *Cyclops Kaufmanni* was very abundant; *Cyclops signatus* and *Diaptomus gracilis* were abundant; *Cyclops insignis*, *C. Ewarti*, *C. strenuus*, and *Diaptomus castor* were less abundant; *Cyclops Thomasi* was rare. CLADOCERA—DAPHNIDÆ: *Bosmina longirostris* and *Sida crystallina* were abundant; *Chydorus sphericus* and the larvæ only of *Leptodora hyalina* were less abundant; *Bythotrephes longimanus*, *Polyphemus pediculus*, and *Daphnia pulex* were rare.

On 15th, 16th, and 17th June, 1898, sixteen tow-nettings were taken at different hours of the day at depths from 0 to about 10 feet from the surface.

This collection was characterized by the presence of the rotifer "*Asplanchna priodonta*" in immense numbers. As it occurred in the same proportion in all the tow-nettings, it must have been universally distributed.

In April the Copepods outnumbered the Daphnids, but in June the Copepods had diminished remarkably in numbers and were replaced by those Daphnids (*Bythotrephes*, *Polyphemus*, *Leptodora*, and *Daphnella*) which were rare in April.

The following COPEPODA were taken:—*Cyclops signatus* was fairly abundant; *C. phaleratus*, *C. strenuus*, *C. serrulatus* were rather rare; *C. insignis* was rare.

DAPHNIDÆ: *Daphnella brachyura*, *Leptodora hyalina*, *Polyphemus pediculus* were very abundant, with eggs, embryos, and young in various stages of development; *Bythotrephes longimanus* with eggs and embryos was abundant; *Sida crystallina* and *Chydorus sphericus* were rare.

A few water-mites were taken which have not yet been identified.

The following species were abundant in April 1898, but were rare or not taken in June:—*Cyclops Kaufmanni*, *C. insignis*, *C. Ewarti*, *Diaptomus gracilis*, *D. castor*, *Bosmina longirostris*, *Sida crystallina*, *Chydorus sphericus*.

Cyclops Thomasi and *Daphnia* were rare in April and were not taken in June.

The following species were common in June which were rare or not taken in April:—*Daphnella brachyura* (absent in April), *Leptodora hyalina* (only larvæ were taken in April), *Polyphemus pediculus*, *Cyclops phaleratus*, and *C. serrulatus* (fairly abundant, but not taken in April), *Bythotrephes longimanus*.

Cyclops signatus and *C. strenuus* were fairly abundant in April and in June.

Brief Statement of recorded Distribution in Britain of the
Species taken in Lake Bassenthwaite.

ENTOMOSTRACA.

CLADOCERA.

Bosmina longirostris, Baird.

Bosmina longirostris, Baird, British Entomostraca, p. 105, tab. xv. fig. iii.

This species appears to be fairly common and widely distributed in Britain. In Bassenthwaite it was very common in all the tow-nettings in April, but rare in June.

Sida crystallina, Straus.

Sida crystallina, Baird, Brit. Entom. p. 107.

Baird remarks that this species is of rare occurrence, but Scott records it as being common in Raith Lake in Scotland. It was the most common species taken in April 1898. In June very few specimens were taken, but these were of a large size, with well-developed ova and embryos.

Chydorus sphaericus, Baird.

Chydorus sphaericus, Baird, Brit. Entom. p. 126, tab. xvi. fig. 8.

Common in ponds and ditches in Britain almost all the year round.

Leptodora hyalina, Lilljeborg.

Leptodora hyalina, Bronn, Klass. und Ordn. des Thier., Arthrop. Crust., Erste Hälfte, Tafeln, Taf. xxi. fig. 1.

This species was first taken in England by Bolton* from the Olton reservoir, near Birmingham. Later it was taken by Beck in Lake Grasmere. Scott has taken it in the Scottish lakes (Loch Leven, Loch Morar), and remarks that while it is considered to be a rare species, it is not very rare in Loch Leven.

In April only the larvæ and very young forms were taken, chiefly at the surface, in Bassenthwaite. In June this species was exceedingly abundant, with eggs, embryos, and young, but no young larvæ were taken. It was, moreover, confined to the middle of the lake, where the water is deep

* Ann. & Mag. Nat. Hist. (5) vol. ix. p. 53. E. Ray Lankester, "On new British Cladocera discovered by Mr. Conrad Beck in Grasmere Lake, Westmoreland."

(see Map, p. 475). Very few mature specimens were taken at the surface, or at the depth of 2 to 4 feet; but from 6 to 10 feet (10 feet = greatest depth at which tow-nettings were taken) it was taken in great quantities.

Bythotrephes longimanus, Leydig.

Bythotrephes longimanus, Leydig, Naturgeschichte der Daphniden, p. 244, figs. 73-75, Taf. x.

British Habitat.—Scotland (Scott): Loch Ness, Loch Morar (frequent at surface), Loch Leven (frequent). Perthshire Lochs (Sept.): Loch Oich (common), Loch Tay (frequent at surface).

This species has not been recorded before from the English lakes. In Bassenthwaite it was very rare in April but very abundant in June, with eggs, embryos, larvæ, and young.

Beck describes the species "*cederstromii*" from Grasmere and other English lakes, and remarks that it appears to be more abundant in the autumn than in the spring.

Daphnia pulex, Latreille.

Daphnia pulex, Baird, Brit. Entom. p. 89, tab. xvi. fig. 5.

This species, while being widely distributed in ponds and ditches in Britain, occurs but rarely in large sheets of water; it was very rare in Bassenthwaite in April, and no specimens were taken in June.

Daphnia longispina.

Daphnia longispina, Baird, Brit. Entom. p. 91, tab. vii. figs. 3, 4.

This species was taken by Beck in the English lakes and by Scott in some of the Scottish lochs. It was rare in April, and no specimens were taken in June.

Polyphemus pediculus, Straus.

Polyphemus pediculus, Baird, Brit. Entom. p. 111, tab. xvii. fig. 1; Leydig, Naturg. der Daphniden, p. 232, Taf. viii. fig. 63, Taf. ix. fig. 71.

Baird took specimens of this species in a ditch near Richmond on Thames; he remarks that this species seems to be very limited in its range of habitat, as he only found it in one spot not more than 20 yards in extent. Scott, however, has taken it in many of the Scottish lakes, and describes it as being a fairly common species, especially in large sheets of water; in Loch Morar, in Perthshire, it was taken by him in

abundance near the surface all over the portion of the loch examined.

Beck took this species in the English lakes. It was very rare in Bassenthwaite in April, but very abundant and universally distributed at the surface and some little distance below the surface in June, with eggs, embryos, and larvæ in all stages of development.

COPEPODA.

Cyclops signatus, Koch.

Cyclops signatus, Brady, Brit. Copep. vol. i. p. 100, pl. xvii. figs. 4-12; id. Revision Brit. Freshwater Cyclopidae and Calanidae, p. 6, pl. ii. fig. 5.

Examples with serrated and with simple ridge on antenna were taken. They are supposed to represent different stages in development (*Herrick*). This species is widely distributed and common in Britain.

Cyclops strenuus, Fischer.

Cyclops strenuus, Brady, Brit. Copep. vol. i. p. 104; id. Rev. Brit. Freshw. Cyc. and Cal. p. 8, pl. ii.

Widely and generally distributed in Britain, but not very common.

Cyclops Thomasi, Forbes.

Cyclops Thomasi, Brady, Freshw. Cyc. and Cal. p. 15, pl. vi. figs. 1-4.

This is not a common species. Scott has taken it in many of the Scottish lakes, but it seems to occur nowhere in great abundance. It was rare in Bassenthwaite in April, this being the first time that it has been recorded from the English lakes. No specimens were taken in June.

Cyclops insignis, Claus.

Cyclops insignis, Brady, Brit. Copep. vol. i. p. 108, pl. xxi.; id. Rev. Brit. Freshw. Cyc. and Cal. p. 18, pl. vii.

Brady describes it as being one of the less common species of *Cyclops*. I have not found it recorded from the Scottish lakes. Specimens of this species were fairly common in the middle of the lake in April, but rare in June.

Cyclops Ewarti, Brady.

Cyclops Ewarti, Brady, Rev. Brit. Freshw. Cyc. and Cal. p. 22.

Scott has taken this species in a small bay near Queensferry, Firth of Forth. Brady remarks that this is the only

undoubted member of this genus which has been found living in the sea. As it was first found in the Forth, he thought that its habitat must be in ponds and ditches which flow into the Forth. Since then it has been taken by Scott in Loch Morar (Inverness-shire) and in Loch Moray.

Only a few specimens of this species were taken in April and none were taken in June.

Cyclops affinis, Sars.

Cyclops affinis, Brady, Brit. Copep. vol. i. p. 112, pl. xv. figs. 11-14, pl. xxiv. B, figs. 10-15; id. Rev. Brit. Freshw. Cyc. and Cal. p. 21, pl. viii.

Brady says that this species seems to be of rare occurrence. Scott records it from some of the Scottish lakes. It was taken in Bassenthwaite in April 1897, and has not since been taken.

Cyclops Kaufmanni, Uljanin.

Cyclops Kaufmanni, Brady, Brit. Copep. vol. i. p. 113, pl. xxiv. figs. 6-12; id. Rev. Brit. Freshw. Cyc. and Cal. p. 24, pl. ii. fig. iii.

This species, although very limited from all accounts in its distribution, was by far the most abundant species taken in April 1898; in June it was rare.

Cyclops phaleratus, Koch.

Cyclops phaleratus, Brady, British Copepoda, vol. i. p. 116.

This species is not very common, though fairly widely distributed. It has been taken in a few of the Scottish lakes by Scott, in Ireland and north of England by Brady, but has not been recorded from the English lakes. It was taken in Bassenthwaite in April 1898, when it was rather rare. No specimens were taken in June.

Cyclops serrulatus, Fischer.

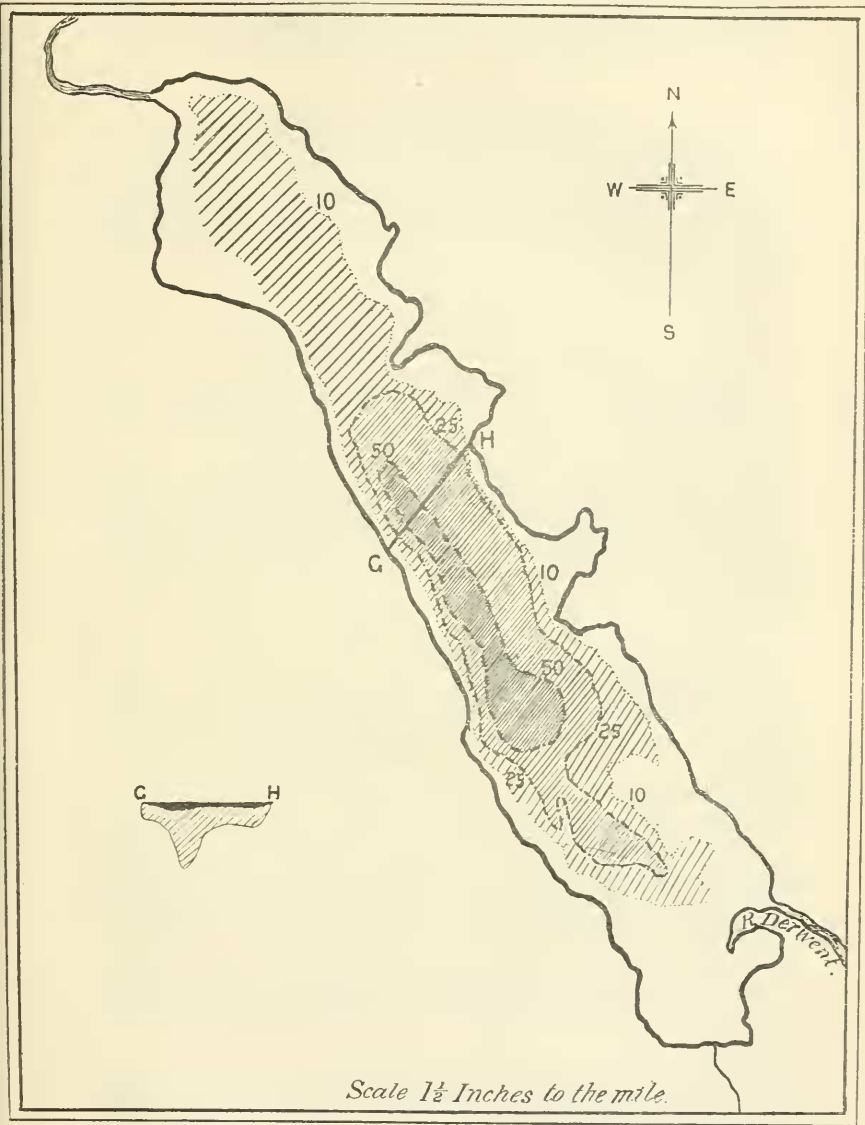
Cyclops serrulatus, Brady, British Copepoda, vol. i. p. 109, pl. xxii.; id. Rev. Freshw. Cyc. and Cal. p. 18, pl. vii. fig. 1.

This is the most common species of the genus. It occurs almost universally over Britain, and has been recorded by almost all continental writers. Specimens were only taken in Bassenthwaite in June.

Diaptomus castor, Jurine.

Diaptomus castor, Brady, Brit. Copepoda, vol. i. p. 59, pl. vi. figs. 6-13; id. Rev. Brit. Freshw. Cyc. and Cal. p. 27, pl. xi. figs. 1-6.

This species is generally distributed in Britain, but not



Bassenthwaite Lake. (Reproduced from 'Bathymetrical Survey of English Lakes,' H. R. Mill, D.Sc.)

common. Brady says that it rarely occurs in lakes or large sheets of water, but generally in ponds and ditches where there is much vegetation. This species was not very abundant in April, and no specimens were taken in June.

Diaptomus gracilis, Sars.

Diaptomus gracilis, Brady, Rev. Brit. Freshw. Cyc. and Cal. p. 29, pl. xi. figs. 7-9, pl. xii. figs. 1-8.

This species is universally distributed and abundant throughout Britain in large sheets of water where there is little vegetation.

ROTIFERA.

Asplanchna priodonta, Gosse.

Asplanchna priodonta, Gosse, Ann. & Mag. Nat. Hist. ser. 2, vol. vi. 1850, p. 18, pls. i. & ii.; Hudson and Gosse, Rotifera, p. 123, pl. xiii. fig. 2.

Gosse found this species not uncommon in the Serpentine, Kensington Gardens, and in ponds and ditches near Birmingham. It was very sparingly but generally distributed in April, but in June occurred in vast quantities in all the tow-nettings taken at the surface and moderate depths.

In the Map accompanying this paper the areas of depth are signified by dotted lines.

The weather was calm and fine when the tow-nettings were made in June, but there had been heavy rains a few days before.

The tow-nettings were confined to the middle and northern portions of the lake.

In the 10-fathom area six tow-nettings were made, and were characterized by the presence of *Polyphemus* in greater numbers than elsewhere, and the almost complete absence of *Leptodora* and *Bythotrephes* (a few immature forms were taken).

In the 25-fathom area four tow-nettings were taken from 6 to 8 feet, in which *Leptodora* and *Bythotrephes* were fairly common.

In the 50-fathom area five tow-nettings were taken from 6 to 10 feet, and in these gatherings *Leptodora* and *Bythotrephes* were very abundant. (It is worthy of note that *Leptodora* and *Bythotrephes* very often occur together in great abundance.)

The remaining forms were distributed more or less universally over the portion of the lake examined.